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ABSTRACT

This unit (which consists of a single lesson) describes the structural and operationally unique features of aerated lagoons. In addition, special troubleshooting and maintenance problems are discussed. The instructor's guide for the unit includes: (1) an overview of the lesson; (2) lesson plan; (3) lecture outline (keyed to a set of slides used with the unit); (4) student worksheet (with answers); and (5) two copies of a final quiz (with and without answers). This unit is heavily dependent upon information presented in the facultative lagoon unit and it is recommended that both units be presented as a set. If it is necessary to present only aerated lagoons, material from the facultative lagoon unit should be referenced and students encouraged to read it ahead of time. (JN)

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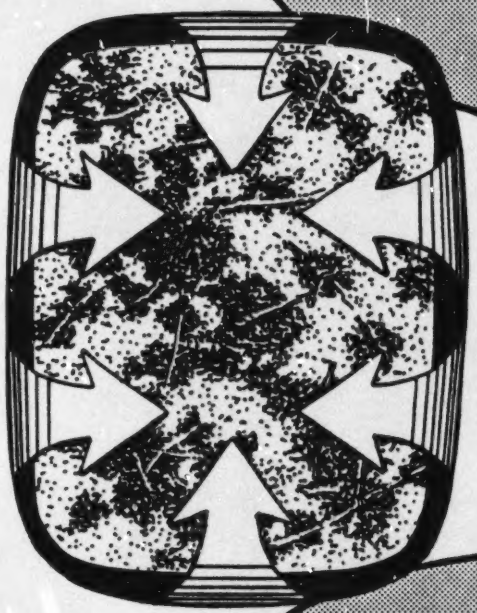
Aerated Lagoons



Instructor's Guide

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SE 045 343

BIOLOGICAL TREATMENT PROCESS CONTROL

AERATED LAGOONS

INSTRUCTOR'S GUIDE

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AERATED LAGOON

Instructor's Guide

Table of Contents

	Page #
Overview of Lesson	I-AL-1
Lesson Plan	I-AL-1
Lecture Outline	I-AL-2
Answers to Worksheet	I-AL-8
Final Quiz	I-AL-10
Answers to Final Quiz	I-AL-14

AERATED LAGOONS

Overview

This unit on aerated lagoons is heavily dependent upon the facultative lagoon unit. Much of the basic theory and description of system components is the same for both processes so the redundant information is not included in this unit. Therefore, they should be presented as a set. If it is necessary to present only aerated lagoons, material from the facultative lagoon unit should be referenced and students encouraged to read it ahead of time.

This unit describes the structural and operationally unique features of aerated lagoons. In addition special troubleshooting and maintenance problems are discussed.

Lesson Plan

- Assign text for students to read ahead of time, if possible. Refer to important sections in facultative lagoon unit.
- Lecture using slides. (Supplement with slides from facultative unit, if necessary.) (30 min)
- Assign worksheet (15 min)
- Correct and discuss worksheet (15 min)
- Assign final quiz.

AERATED LAGOONS

LECTURE OUTLINE

Slide #

#1 & #2

Introduction

Title & Credit Slides

Similar to conventional activated sludge except in earthen basin.

#3, #4 & #5

Mechanical induction of air provided.

Usually built deeper (5-15 ft) than facultative lagoons.

Organic loading higher (60-200 lbs BOD/acre/day).

Aerated lagoons divided into three different types:

completely mixed

facultative aerated

aerated oxidation pond

More energy and maintenance costs.

Design and Theory of Types

Capable of achieving good treatment without high construction cost required of conventional activated sludge.

Recently, secondary settling with aerated lagoons helps meet strict secondary standards.

Advantages of aerated lagoons:

Can be deeper so require less land.

Uniform D.O. throughout.

Not dependent upon sun for oxygen by photosynthesis.

Treat greater organic loads.

Disadvantages of aerated lagoons:

Greater energy required to supply oxygen.

Greater maintenance required.

Easily affected by temperature.

Usually require sedimentation unit following treatment.

Completely Mixed Aerated Lagoon

Modification of activated sludge process.

Strictly aerobic, no algae present.

Organic stabilization dependent upon suspended bacterial solids. Usually no sludge return.

BOD reduction of 48-62% in 24 hrs.

BOD reduction of 85% is followed by sedimentation.

Advantages:

BOD effluent characteristics highly predictable.

Basins can be smaller.

Disadvantages:

More sensitive to temperature.

Require aerators capable of scouring; this means high power consumption

Effluent BOD and SS high if sedimentation not provided.

Settling Ponds

Usually ponds rather than conventional clarifier.

Settling ponds following treatment should have 1-5 day detention.

Facultative Aerated Lagoon

Provide enough mixing to maintain biological treatment but allow solids to settle.

Provide 7-20 day detention.

Settled solids stabilized anaerobically.

Aeration equipment provides 1.5 - 2.0 lbs oxygen per HP/hr.

BOD reduction of 70-80% with 4-8 days detention.

Advantages:

Stabilization and solids separation in same pond.

Even distribution of solids compared to normal facultative ponds.

Less energy required than for completely mixed aerated lagoon.

Effluent SS and BOD lower than completely mixed aerated lagoon.

Disadvantages:

Minimal control over biological process.

May have problems with solids buildup at inlet if not positioned correctly.

Aerobic activity decreased in winter.

Sludge must be removed occasionally.

Solids resuspension by methane production during summer.

Aerated Oxidation Pond

An upgraded, high rate oxidation pond.

Oxygen usually provided by diffused air.

Advantages:

- High BOD removal.
- Economical upgrading.
- Minimum scouring velocities needed so aeration devices can be efficient and economical.
- Sludge removal infrequent.

Disadvantages:

- Odor problem if there is turnover.
- Larger basins required due to larger surface area requirements.

The Effects of Temperature on Aerated Lagoons

- Temperature has greater impact because of long detention time and relatively low solids.
- Changing to series flow pattern can decrease the impact.
- Ice related problems:
  - Damages mechanical aerators.
  - Embankment erosion caused by repeated freezing and thawing.
  - Freezing discharge line.
- Ice can cover lagoon and prevent heat loss.
- Temperature affects rate of oxygen transfer.

Aeration Devices

- Not necessary to have scouring velocity and suspend all solids but must mix completely.
- Mechanical surface aerators. #6, #7, #8, #9 & #10
  - Float-mounted or stationary
  - Propeller and turbine types

High Speed Aerator (Propeller)

Sprays liquid into air

Small, float mounted, direct drive

Slow Speed Aerator (Turbine)

Hydraulic jump pulls air in behind blades.

Large blades, gear drives, float or platform mounted.

Mechanical aerators increase heat loss, can ice-up, tip over, sink.

#11

Diffused Aerators

Used for high loadings and deeper lagoons.

Better oxygen transfer.

Fewer freezing problems.

Air Gun

Combination of diffused air and surface aeration.

Good for cold areas and deep lagoons.

Plastic Tubing

Slits along top of tubing.

Layed out on grid, recommended 10 ft deep.

#12 & #13

Air Tube Diffuser

Compressed air up through internal helix.

Lagoon Testing

Influent testing - Flow, BOD, pH, TSS, Temp., D.O.

Effluent Testing - BOD, TSS, pH, D.O.

Aerated Ponds - TSS, D.O., Respiration Rate, SSV 30, pH, D.O. Profiles, Micro counts.

Completely mixed lagoons D.O. Profiles -

Used to check for D.O. dead spots.

Aerated Facultative Lagoons Profiles -

Used to check D.O. dead spots and to determine amount of accumulated sludge.

Design Considerations

Operational Considerations

Various flow pattern combinations

Variable depth control

Maintenance

SAM - Simple Automatic Maintenance System

Maintenance Records

Diffuser clogging

Air-side clogging

Liquor-side clogging

Air Filters

Manual

Automatic

Bag-type

Blowers

Mechanical Aerators

Answers to Worksheet

1. Aerated lagoons are similar to conventional activated sludge except the activity takes place in earthen basins.

2. Aerated lagoons are usually (deeper or shallower) than facultative lagoons.

3. Aerated lagoons can generally handle (higher or lower) organic loads than facultative lagoons.

4. Aerated lagoons consume more energy and require more maintenance time.

5. The three types of aerated lagoons are:

   completely mixed lagoon

   facultative aerated lagoon

   aerated oxidation pond

6. The completely mixed type aerated lagoon provides sufficient aeration to suspend all of the solids but not necessarily enough to keep the entire system aerobic.

7. The facultative aerated type aerated lagoon provides sufficient air to maintain the biological activity but allows solids to settle.

8. The aerated oxidation pond type aerated lagoon is essentially a high rate oxidation pond with air usually supplied by diffused air aeration.

9. The completely mixed aerated lagoon can be expected to reduce BOD by 48-62 % without sedimentation and 85 % with sedimentation.

10. During freezing weather ice can cause damage to mechanical aerators.

11. Ice can cover lagoons and minimize heat loss.

12. The two types of mechanical aerators are:

Propeller

Turbine

13. The propeller type aerator is small, direct drive and sprays liquid into the air.

14. The turbine type aerator has large blades, gear drive and creates a hydraulic jump to pull air into the liquid.

15. The three types of diffused air aerators are:

Air Gun Air Tube Diffuser

Plastic Tubing

16. Profiles can be used in lagoons to measure D.O. and to estimate the accumulation of settled solids.

17. SAM stands for Simple Automatic Maintenance.

18. Give one advantage and one disadvantage for each type of aerated lagoon:

Type	Advantage	Disadvantage
Completely Mixed	- BOD eff. predictable - Basin smaller	- Temp. sensitive - Requires scouring - Eff. BOD & SS poor if no sedimentation
Facultative Aerated	- Stab. & sed. in same pond - Even dist. of solids - Less energy - Better eff. SS & BOD	- Minimal control - Problems with solids buildup - Sludge must be removed - Solids resuspension during summer - Decrease activity in winter
Aerated Oxidation Pond	- High BOD removal - Economical upgrading - Sludge removal infrequent - Requires minimal scouring action	- Odor problems with spring turnover - Larger basins required

AERATED LAGOONS

Final Quiz Name _____

Multiple Choice: Choose the one best answer and place an "X" in front of the corresponding letter.

1. Which of the following is NOT a general characteristic of aerated lagoons?

   _____ a. Mechanically induced air.
   _____ b. 5-15 ft deep.
   _____ c. 60-200 lbs BOD/acre/day
   _____ d. Algae produce oxygen
   _____ e. Generally in earthen basins

2. The type of aerated lagoon where all the solids are kept in suspension by aeration is called

   _____ a. completely mixed
   _____ b. facultative aerated
   _____ c. aerated oxidation pond
   _____ d. extended aeration pond
   _____ e. oxidation ditch

3. The type of aerated lagoon in which aeration provides minimal scouring usually by diffused air aeration devices is called

   _____ a. completely mixed
   _____ b. aerated oxidation pond
   _____ c. facultative aerated
   _____ d. contact stabilization
   _____ e. extended aeration

4. The type of aerated lagoon in which the aeration provides sufficient D.O. to maintain biological activity but not suspend the solids is called

   _____ a. completely mixed
   _____ b. facultative aerated
   _____ c. aerated oxidation ponds
   _____ d. conventional activated sludge
   _____ e. contact stabilization

5. The expected BOD reduction for a completely mixed aerated lagoon with sedimentation is

_____ a. 20-25%
_____ b. 30-40%
_____ c. 48-62%
_____ d. 66-70%
_____ e. 90-95%

6. The expected BOD reduction of the facultative aerated lagoon is

_____ a. 40-45%
_____ b. 50-60%
_____ c. 60-70%
_____ d. 70-80%
_____ e. 80-90%

7. Temperature has a greater impact on stabilization in aerated lagoons than facultative lagoons because

_____ a. they can only be operated in series.
_____ b. there is not adequate algae present.
_____ c. aerators spray the liquid into the air.
_____ d. solids tend to build up at the inlet.
_____ e. of long detention time and relatively low solids.

8. Which of the following is NOT a problem with lagoons in the winter?

_____ a. Ice damage to mechanical aerators.
_____ b. Heat loss when lagoon is covered with ice.
_____ c. Embankment erosion caused by thawing.
_____ d. Freezing of discharge lines.
_____ e. Floating aerators tip over or sink.

9. Mechanical aerators which have large blades, gear drives, and create a hydraulic jumpto pull air into the liquid are

_____ a. air guns
_____ b. compressed air
_____ c. propeller
_____ d. turbine
_____ e. usually high speed

10. Mechanical aerators which are small, direct driven and spray the liquid into the air are

_____ a. air guns
_____ b. usually slow speed
_____ c. propeller
_____ d. turbine
_____ e. usually platform mounted

11. BOD, TSS, pH, and D.O. are tests that should be run on

_____ a. influent only
_____ b. effluent only
_____ c. the pond itself
_____ d. influent and effluent
_____ e. b and c above

12. Micro counts are used to

_____ a. determine the status of the floc in the pond.
_____ b. determine the effluent fecal coliforms.
_____ c. determine the effluent total coliforms.
_____ d. count the number and types of pathogens present.
_____ e. estimate effluent suspended solids.

13. The procedure used to check the lagoon for dissolved oxygen dead spots is the

_____ a. BOD test
_____ b. Respiration Rate
_____ c. TSS
_____ d. D.O. profile
_____ e. pH

14. Liquor-side clogging in diffused air systems results from

_____ a. dirt in the air
_____ b. precipitated deposits such as carbonates
_____ c. rust or scales in air pipe
_____ d. oil in air from faulty compressor
_____ e. oxidation of air pipe coatings

15. Which of the following is NOT a routine maintenance procedure for blowers?

_____ a. Inspect oil levels

_____ b. Check and record inlet and outlet pressure

_____ c. Check for unusual noise, vibration, or overheating

_____ d. Check and record voltages and amperages on motor

_____ e. Replace air filter daily

Answers to Final Quiz

Name _____

Multiple Choice: Choose the one best answer and place an "X" in front of the corresponding letter.

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